
ADVANTEST®

ADVANTEST CORPORATION

INSTRUCTION MANUAL

TR4120A

TRACKING SCOPE

MANUAL NUMBER OEB00 9005

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1.1 General

1. GENERAL INFORMATION

1.1 General

TR4120A is a tracking scope having the following performance:

Measurement range: 100Hz to 30MHz
Resolution : Max. 10Hz
Input sensitivity: Max. -135dBV
Dynamic range : 80dB

Furthermore, since TR4120A includes a tracking generator, it directly reads and analyzes the frequency characteristics in addition to analyzing the spectrum. Also, connecting an ADVANTEST frequency counter to this device provides a function to read the frequency on the marker point at an accuracy specified by the frequency counter.

This tracking generator is operated as a selective amplifier (or tuned amplifier.) Using this function, some weak signal is selected and amplified. The ON-AIR signal can be measured at an accuracy specified by the carrier frequency counter.

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1.2 Check of Attachments

1.2 Check of Attachments

Upon receipt of this equipment, run checks thereon as shown below.

- ① Run visual checks against any and all damages or imperfections.
- ② Check the quantity and rating of standard attachments to assure their conformance with Table 1-1.

Should there be any flaw, or damage, or missing or insufficient part, contact the nearest dealer or the sales and support offices.

Request to User: When ordering add-on attachments and the like, be good enough to stipulate the model (or stock No.) concerned.

Table 1 - 1 Standard Attachments

	Product name	Model	Stock No.	Q'ty	Remarks
1	Power cable	MP-43B (A01402)	DCB-DD2428x01	1	With adapter
2	Input cable	MO-15	DCB-FF0442	2	
3	Allen wrench	3mm	-	1	
		4mm	-	1	
4	Slow-blow fuse	EAWK-1.25A	DFT-AA1R25A	2	For line voltage of 100/120V
		EAWK-0.63A	DFT-AAR63A		For line voltage of 220/240V
5	Instruction Manual	-	JTR4120A	1	Japanese
		-	ETR4120A		English

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1.3 Storage

1.3 Storage

If you do not use this device for the time being, wrap it with vinyl sheet. Then, put it into the corrugated cardboard to store in the low-humid place where the package is not exposed to the direct rays of sun. The temperature condition should range from -25°C to $+70^{\circ}\text{C}$.

MEMO



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2.1 Spectrum Analyzer

2. SPECIFICATIONS

2.1 Spectrum Analyzer

(1) Frequency Specifications

Measuring range	:	100Hz to 30MHz
Center frequency accuracy	:	Within $\pm 500\text{kHz}$
Frequency span	:	At SPAN/DIV switch
	:	50Hz/div to 20MHz/div
	:	1, 2, 5 step
Frequency span accuracy	:	Within $\pm 10\%$
Stability	:	
Residual FM	;	5Hz _{p-p} (after automatic stabilization)
Noise sideband	;	Less than -55dB
		(at 100Hz IF bandwidth, more than 2kHz away from carrier)
Resolution	:	
3dB bandwidth	;	10Hz to 100kHz
	:	1, 3 step
Resolution bandwidth accuracy:		$\pm 25\%$ (at 3dB bandwidth)
Bandwidth selectivity	:	Less than 20:1 (60dB:3dB ratio)
Resolution bandwidth switching accuracy:		Within $\pm 1\text{dB}$ (at 100kHz to 30Hz bandwidth)
		Within $\pm 2\text{dB}$ (at 10kHz bandwidth with 10kHz as reference)

(2) Amplitude Specifications

Reference level	:	+40dBV to -70dBV
		10dB steps
		The value is continuously variable within the range.
Reference level accuracy	:	$\pm 0.5\text{dB}$
Y axis scale selection	:	10dB/div, 2dB/div, LIN., LIN.x5
Level indication accuracy	:	Less than $\pm 1\text{dB}$ (at 10dB)
		Less than $\pm 2\text{dB}$ (at 80dB)
Dynamic range	:	
Noise level	;	-95dBV (at 100kHz bandwidth)
	;	-135dBV (at 10Hz bandwidth)
Spurious response	;	Less than -60dB (at -40dBV input)
Residual response	;	Less than -110dB (at RF. ATT. 0dV, no input)
Display dynamic range;		80dB
Video bandwidth	:	10Hz, 100Hz, 10kHz, OFF
Frequency response	:	1dB _{p-p}
Gain compression	:	Less than 1dB
		(at -25dBV input for 100Hz to 1MHz or 20dBV input for 1MHz to 30MHz)
Gain stability	:	Less than $\pm 0.1\text{dB}/^\circ\text{C}$

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2.1 Spectrum Analyzer

(3) Input Specifications

Input connector : BNC type
Inpt impedance : $1M\Omega$, less than 18pF
(The impedance can be changed from $1M\Omega$
to $10M\Omega$ by co-using the oscilloscope
probe.)
Input attenuator : 0dB to 50dB, 10dB step
Maximum input sensitivity : -135dBV
Maximum permissible input level:
100Vrms. (at 50dB input ATT.)
 $\pm 150VDC$

(4) Sweep Specifications

Sweep time : $10\mu s/div$ to $10s/div$
1, 2, 5 step
Sweep mode : SINGLE, MANUAL, INT.
Sweep trigger : VIDEO, EXT., LINE, FREE RUN

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2.2 Tracking Generator

2.2 Tracking Generator

Frequency range	:	100Hz to 30MHz
Output level	:	+10dBm to -40dBm
Output level accuracy	:	±0.5dB
S/N ratio of output	:	-30dB or less with respect to the signal (except high frequency)
Output impedance	:	Approx. 75Ω
Frequency response	:	Within ±0.5dB (10MHz as reference)
Stability	:	Corresponds to stability of spectrum analyzer
AGC	:	ON (Response up to 30Hz) OFF
T.G. mode	:	
TUNED ANP	;	Selects and amplifies a signal of more than 0dB or S/N ratio, more than -70dB CRT display, and outputs as more than 100mVrms. The peak value in the local frequency range is counted with the counter.
NORMAL	;	The frequency specified by the marker can be correctly read with the counter.
Counter output	:	Level 100mVrms. Impedance 75Ω

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2.3 General Specifications

2.3 General Specifications

CRT display	:	Scale 8 x 10div Square P39 afterglow
X axis output	:	Approx. 4V, impedance 10k Ω
Y axis output	:	Approx. 2V, impedance 10k Ω
Z axis output	:	TTL level (blanking at Lo)
Storage environment	:	-25 to +70°C
Operating environment	:	0 to 40°C
Line voltage	:	
Standard	;	90 to 110V (100VAC)
Option 31	;	105 to 125V (115VAC)
Option 41	;	180 to 220V (200VAC)
Option 43	;	210 to 250V (230VAC)
Power frequency	:	48 to 66Hz
Power consumption	:	75VA MAX.
Dimensions	:	Approx. 300(W) x 170(H) x 470(D) mm
Weight	:	16kg MAX.

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3.1 General preparations
and Precautions Prior to Use

3. OPERATING INSTRUCTIONS

3.1 General Preparations and Precautions Prior to Use

- (1) Confirm that the POWER switch is set to OFF before connecting the power cable.
- (2) Always use an AC line voltage of the set value $100\text{VAC} \pm 10\%$.
- (3) Since the tracking scope is not equipped with a cooling fan, pay attention to the ambient ventilation and never place anything on the instrument.
- (4) Use within an ambient temperature range of 0°C to $+40^{\circ}\text{C}$.
- (5) Absolute storage temperature range is -20°C to $+70^{\circ}\text{C}$.
- (6) When the power line is extremely noisy, use a noise filter, etc.
- (7) Always mount the front protection cover to the instrument when it is not in use to prevent mechanical damage to the front panel.

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3.2 Panel Description

3.2 Panel Description

-Front Panel-

Name		Function
①	TG OUT Connector	Connector where the signal from the tracking generator is output. Output impedance is approx. 75Ω.
②	OUTPUT LEVEL switch	Determines the output level of the tracking generator. Level can be changed from +10dBm to -40dBm in 10dBm steps.
③	FREQ. ADJ. control	Used in order to match the T. G. OUT. signal to the receiving frequency when the MODE switch is set to NORMAL. Primarily used at a RES BW of 100Hz or lower.
④	MODE switch	
	NORMAL	Set to this position when changing the frequency by synchronizing the output of the tracking generator with the sweep. Set to this position during normal measurement.
⑤	TUNED AMP.	Set to this position when the signal connected to INPUT is selected, amplified, and then output from T. G. OUT. When the MODE switch is set to this position, the instrument operates as selective amplifie.
	AGC switch	In order to stabilize the signal level, AGC is provided in the tracking generator. However, since the frequency range of the oscillator output is wide and the SWEEP TIME is fast, the AGC cutoff frequency must be relatively high. The AGC cutoff frequency of this instrument is 30kHz. Set this swicth to ON when the tracking generator output is above 30kHz and to OFF when the ouput is below 30kHz.
⑥	MARKER POSITION control	The frequency at the marker indicated at this control can be read when connected to an extenal counter. The marker is intensity-modulated on the CRT display. Not operative when a counter is not connected.
⑦	SWEEP MODE switch	Selects the sweep mode.
	SINGLE	Set to this position for a single sweep. When the button at the top is depressed, a single sweep is performed. Sweep speed is determined by the internal sweep time.

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3.2 Panel Description

Name		Function
	MANUAL	In this mode, the marker can be shifted to any arbitrary point by means of the MANUAL SWEEP control. Use this mode for the measurement or observation at any fixed point.
	INT	Sweep is performed at the speed set with the internal SWEEP TIME/DIV. switch.
⑧	SWEEP TRIGGER switch	Selects the sweep start timing.
	VIDEO	Sweep is started at a certain amplitude on the CRT display, as it is on an oscilloscope. Can be synchronized with the modulated signal for the observation of the modulated signal when the carrier is amplitude modulated (AM) or frequency modulated (FM).
	EXT	Set to this position when sweep is to be performed with a signal ($2V_{p-p}$, 50Hz to 250kHz) applied to the EXT. TRIGGER terminal on the rear panel.
	LINE	Sweeping is synchronized with the power line frequency. Variations in signals modulated by the power line can be eliminated by setting the switch to this position.
	FREE RUN	Sweeping is automatically repeated by means of the internal circuitry.
⑨	VIDEO BW switch	Selects the cutoff frequency of the CRT display driver. Use this switch when the signal is noisy. The noise is rejected by the integration and the waveform can be clearly observed.
⑩	SPAN switch	Selects the local oscillator sweep mode.
	FULL	Sweep in single sweep from 0 to 30MHz. will not vary the spectrum on the CRT with the TUNING control.
	PER/DIV.	Sweeping is performed as set with the SPAN/DIV. switch. Center frequency is determined by the setting of the TUNING control.
	ZERO	Mode in which the local oscillator is not swept. Same as a common selective level meter. Receiving frequency can be selected with the TUNING control. Horizontal axis is set up with the SWEEP TIME control.

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3.2 Panel Description

Name	Function												
⑪ VERT./DIV. switch	Selects the gain of the vertical axis from dB mode or LIN. mode. A gain of 5X each is possible.												
dB	The signal is converted to decibel. Scale division can be switched between 10dB and 2dB.												
LIN.	The signal is amplified five times based on the reference level displayed on the CRT. The relationship between the linear scale and reference level (dBV) is as follows: <table><tr><td>REFERENCE LEVEL</td><td>+20dBV</td><td>0dBV</td><td>-20dBV</td><td>-40dBV</td><td>-60dBV</td></tr><tr><td>Linear scale (/DIV.)</td><td>1V</td><td>100mV</td><td>10mV</td><td>1mV</td><td>100μV</td></tr></table>	REFERENCE LEVEL	+20dBV	0dBV	-20dBV	-40dBV	-60dBV	Linear scale (/DIV.)	1V	100mV	10mV	1mV	100μV
REFERENCE LEVEL	+20dBV	0dBV	-20dBV	-40dBV	-60dBV								
Linear scale (/DIV.)	1V	100mV	10mV	1mV	100μV								
⑫ TUNING control													
COARSE	A control for setting the center frequency. Turning this control changes the center frequency displayed, since the first stage sweep oscillator frequency is changed.												
FINE	A control for adjust the frequency finely. The frequency can be varied within the range of approx. 100kHz. The frequency of the third sweep oscillator is changed. Use only the "FINE" control if the "SAPN/DIV." switch is set to the value of less than 10kHz.												
⑬ INPUT connector	Input impedance is 1MΩ/18pF. Maximum input voltage is 100Vrms, ±150VDC with RF ATT switch set to 50dB.												
⑭ INPUT ATT control	An "INPUT" attenuator. Use this control when the input signal is too large, or you want to improve the standing wave ratio. When this control is changed 10dB, the signal waveform on the CRT is also varied 10dB.												
⑮ REFERENCE LEVEL switch	A switch so that the horizontal scale on the CRT display is selected and set. If the reference level is set within the range from 10kHz to 50Hz, use the "FINE" control.												

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3.2 Panel Description

Name	Function
⑩ REFERENCE LEVEL switch	A switch to set the "0dB" position on the scale on the CRT display. By turning this switch, the IF amplifier gain is varied. Also, this switch links the "INPUT ATT." switch.
⑪ BANDWIDTH switch	Using this switch, the IF bandwidth, determining the resolution of the spectrum analyzer, is selected.
⑫ IF LEVEL ADJ.	Adjusts the vertical axis gain. Gain can be varied approximately 10dB.
⑬ SWEEP TIME/DIV. switch	Selects the sweep time.
⑭ WARNING lamp	Indicates that the level indication on the CRT display is not accurate. If this lamp lights, adjust RES BW, SWEEP TIME/DIV., SPAN/DIV. or VIDEO BW so that this lamp is turned off.
⑮ SWEEP lamp	Indicates that the instrument is sweeping. Lighted at the beginning of sweeping and extinguished at the end of sweeping.
⑯ CRT display	CRT to display the spectrum.
⑰ INTENSITY control	Adjusts the intensity of the CRT display. Intensity increases when this control is turned clockwise.
⑱ FOCUS control	Focuses the CRT display trace.
⑲ GRASS CLIPPER control	When there is a noise at the baseline of the CRT display, it becomes extremely bright with respect to the signal. The low level portion can be eliminated by turning this control clockwise.
⑳ SCALE ILLUM control	Controls the illumination of the CRT display graticule. Illumination increases as this control is turned clockwise and decreases when the control is turned counterclockwise.
㉑ POWER switch	Power is supplied and the instrument is placed in the operative state approximately 15 seconds later when this switch is set to ON.

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3.2 Panel Description

Name	Function
28 TG AUX. OUT. terminal	Tracking generator auxiliary output terminal. Output voltage is 100mVrms or more, output impedance is approximately 75Ω.
29 X AXIS terminal	Used when recording the X-axis signal of the CRT display with an external recorder. Output voltage is 0V to 3.5V. Output impedance is 10kΩ. Output voltage can be changed in the range from 0.8V to 3.5V by turning the lower volume.
30 Y AXIS terminal	Used when recording the Y-axis signal of the CRT display with an external recorder. Output signal is 2.5V _{p-p} . Output impedance is approximately 10kΩ.
31 Z AXIS terminal	Blanking output connector. TTL level output. Blanks at TTL low level.
32 EXT. TRIGGER terminal	Connect the signal to this terminal when starting sweep with an external signal. Trigger is applied by a 50Hz to 250kHz, 2V _{p-p} or more signal. When the trigger signal is externally input, select "EXT" on the front panel "SWEEP TRIGGER" switch.
33 GND terminal	Instrument frame ground terminal. Connect this terminal to the ground when the instrument is used. The capacity is 100VAC±10%.
34 Power connector	Accessory power cable connector.
35 LINE FUSE	A power supply fuse of this instrument. 1.25A slow-blow fuse is used.
36 COUNTER CONTROL	Connect this connector to the DATA OUT. connector of the counter when the tracking scope is used in conjunction with a ADVANTEST counter.

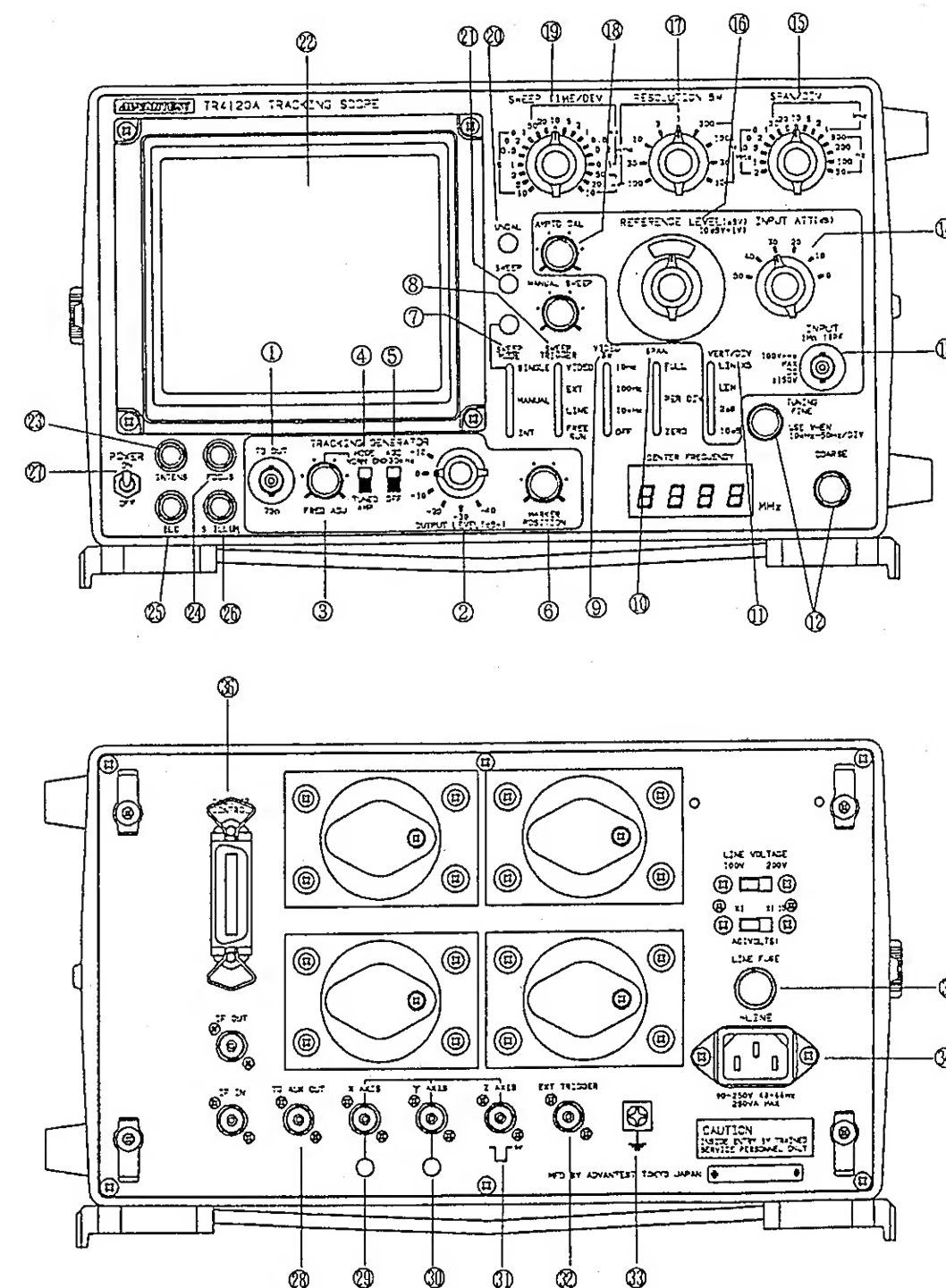


Figure 3 - 1 Panel Description

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3.3 Level Calibration

3.3 Level Calibration

The method of calibrating the level using a tracking generator is described here.
Allow the instrument to warm up for at least 30 minutes before calibration.

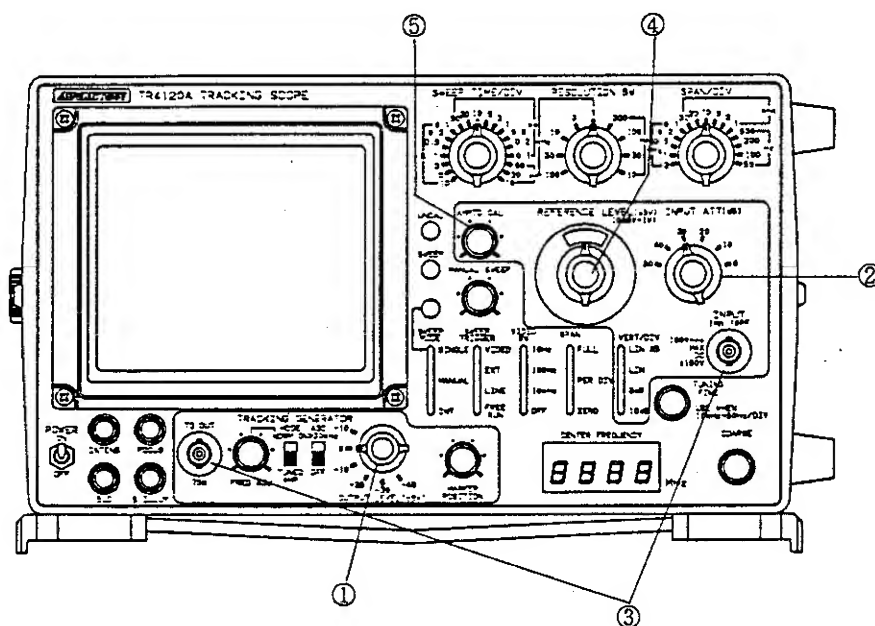


Figure 3 - 2 Level Calibration

- (1) Set the OUTPUT LEVEL switch to the -20dBm position.
- (2) Set the INPUT ATT switch to the 0dB position.
- (3) Connect the TG OUT connector and INPUT connector with a cable.
- (4) Set the REFERENCE LEVEL switch to -10dBV.
- (5) Adjust the trace on the CRT display to -25dBV (1.5 divisions from the top of the scale) with the AMPTD CAL control.

This calibrates the instrument in dBV. Since the INPUT input impedance is $1\text{M}\Omega$ when -20dBm (75Ω) is directly connected, the voltage actually output from TG OUT is -14dBm, 6dB higher than the output level setting. On the other hand, -14dBm, if converted to dBV, becomes -25dBV. When the INPUT connector is terminated in 75Ω , the actual output voltage is 6dB lower and the CRT display trace indicates -31dBV. Consequently, for direct reading in dBm, shift the REFERENCE LEVEL control -10dB and calibrate with the AMPTD CAL control.

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3.3 Level Calibration

Conversion Table
of
dBm/50Ω, dBm/75Ω, Vrms, W/50Ω, dBμ, dBV

dBm/75Ω	dBV	dBm/50Ω	dBμ	Vrms	W/50Ω
		+30dBm			1W
				5Vrms	500mW
+20dBm	+10dBV		130dBμ		100mW
	+20dBm				50mW
+10dBm	0dBV		120dBμ	1Vrms	10mW
	+10dBm			500mVrms	5mW
0dBm	-10dBV		110dBμ		1mW
	0dBm				500μW
-10dBm	-20dBV		100dBμ	100mVrms	100μW
	-10dBm			50mVrms	50μW
-20dBm	-30dBV		90dBμ		10μW
	-20dBm				5μW
-30dBm	-40dBV		80dBμ	10mVrms	1μW
	-30dBm			5mVrms	500nW
-40dBm	-50dBV		70dBμ		100nW
	-40dBm				50nW
-50dBm	-60dBV		60dBμ	1mVrms	10nW
	-50dBm			500μVrms	5nW
-60dBm	-70dBV		50dBμ		
	-60dBm				
-70dBm	-80dBV		40dBμ	100μVrms	
	-70dBm			50μVrms	
-80dBm	-90dBV		30dBμ		
	-80dBm				
-90dBm	-100dBV		20dBμ	10μVrms	

0dBV = 1Vrms
0dBμ = 1μVrms
0dBm = 1mW
R = 50Ω

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3.4 Use as a Spectrum Analyzer

3.4 Use as a Spectrum Analyzer

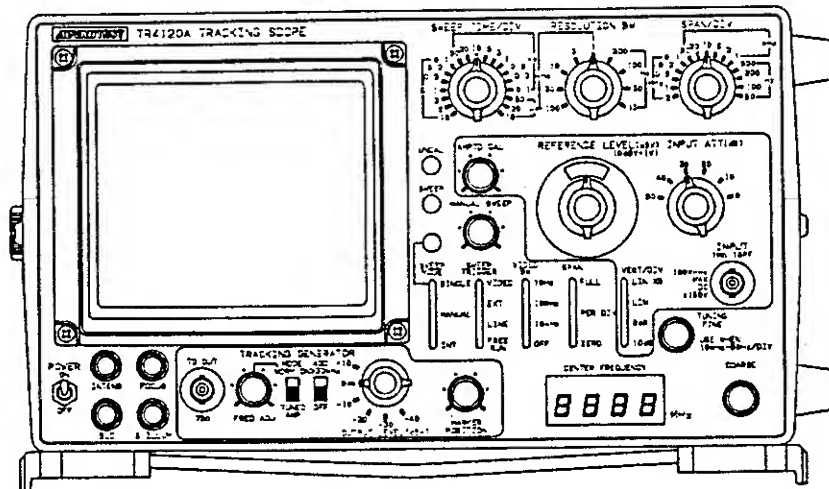


Figure 3 - 3 Use as a Spectrum Analyzer

(1) Set the front panel controls as follows:

VERT./DIV.	10dB
SPAN	PER DIV.
VIDEO BW	OFF
SWEEP TRIGGER	AUTO
SWEEP MODE	INT.
INPUT ATT	0dB
REFERENCE LEVEL	-10dBV
SPAN/DIV.	2MHz
RESOLUTION BW	100kHz
SWEEP TIME/DIV.	1ms
BLC	Fully counterclockwise
TUNING COARSE	0MHz
(Center frequency)	

(2) Set the POWER switch to the ON position.

The trace will appear on the CRT display about 15 seconds later.
Adjust the clarity of the trace with the INTENS and FOCUS controls.

(3) At this time, the spectrum appearing at the center of the CRT display is zero frequency, swept from the center to the right with 2MHz per division.

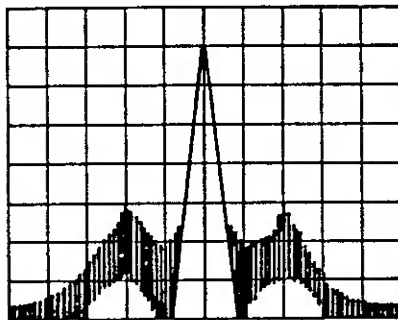
For example, a 2 MHz signal will appear at 1 division to the right of the zero frequency spectrum. A spectrum also appears at the left of the zero frequency, but the level and frequency axes for this spectrum are not accurate.

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3.4 Use as a Spectrum Analyzer

- (4) Apply the unknown signal to the INPUT connector with a cable.
When the level of the signal to be measured is unknown, set RF ATT to the 50dB position and then turn the INPUT ATT switch clockwise while observing the spectrum on the CRT display.
- (5) Turn the COARSE control and position the spectrum to be observed to the center of the CRT display.
- (6) Set the SPAN/DIV. switch for optimum observation conditions.
At this time, set the SPAN/DIV. switch while placing the spectrum to the center of the CRT display with the COARSE control. After centering the spectrum on the CRT display with the SPAN/DIV. switch set to the 20kHz position, switch the SPAN/DIV. switch to the 10kHz position.
At this time, adjust the COARSE control so that the spectrum appears on the CRT display and then place the spectrum to center of the CRT display with the FINE control.
When the spectrum disappears in this state, it can be returned to its original position with the COARSE control.
- (7) Set the RESOLUTION BW switch so that the spectrum is easy to observe as well as the SPAN/DIV. switch.
When the UNCAL lamp is lighted with the RESOLUTION BW switch turned clockwise, lengthen the sweep time by turning the SWEEP TIME switch clockwise.

[Note on observation]



SPAN/DIV.: 5kHz
RBW : 300Hz

When the SPAN/DIV. switch is set to 10kHz or narrower, increased noise is observed near the spectrum. This is due to noise derived from the TR4120A.

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3.5 Use as a Frequency
Response Direct Observation Device

3.5 Use as a Frequency Response Direct Observation Device

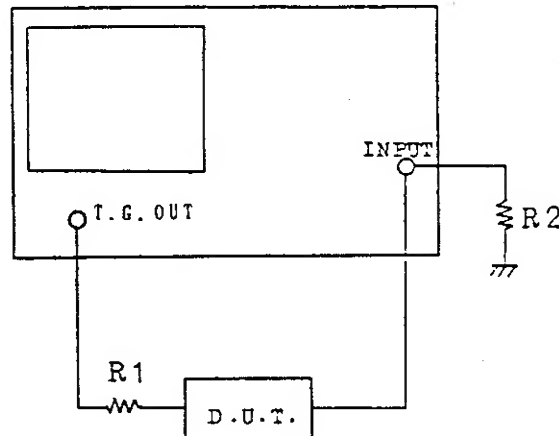


Figure 3 - 4

- (1) Set the controls as described in paragraph 3.4 (1), connect TG OUT to the input of the device under test (DUT), and connect the output of the DUT to the INPUT terminal of the tracking scope.
- (2) Since the input impedance of the TR4120A is $1M\Omega$, termination necessary (R2).
The output impedance of T. G. OUT. is 75Ω . In order to match the impedance when the DUT has an input impedance of 75Ω or higher, insert a resistor (R1) having a resistance 75Ω lower than the input impedance of the DUT in series with T. G. OUT.
- (3) When you select "FULL" on the "SPAN" switch, you can directly see the characteristics of the frequencies ranging from 0 to 30MHz. When you select "PER DIV." on the switch you can see the frequencies ranging from 0 to 30MHz arbitrarily.
- (4) When you select "PER DIV." on the "SPAN" switch, the measurement is carried out by selecting an desirable frequency with the "COARSE" control and setting the frequency range with the "SPAN/DIV." switch. This time, on turning the "RESOLUTION BW" switch clockwise, the signal whose noise side band is less than that of TR4120A can be measured.

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3.5 Use as a Frequency
Response Direct Observation Device

- (5) Select the "VERT/DIV." switch if necessary.
- (6) By using the oscilloscope probe, you can measure the frequency characteristic now being processed in the circuit and measure the mismatching attenuation.

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3.6 Frequency Measurement

3.6 Frequency Measurement

The method of measuring the frequency of the spectrum displayed on the CRT display with a counter is described here.

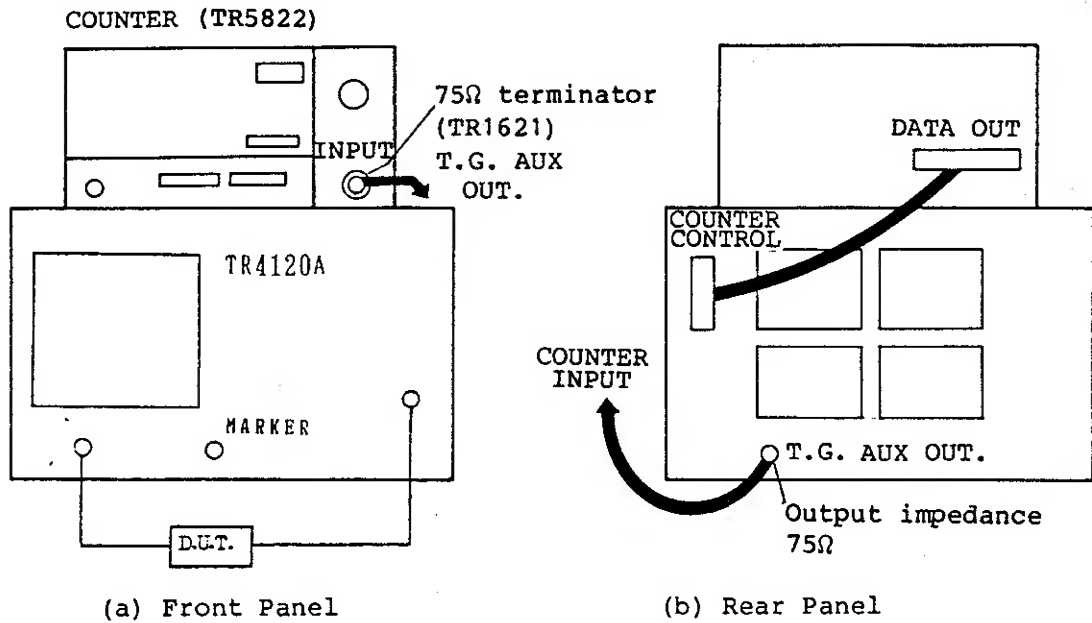


Figure 3 - 5

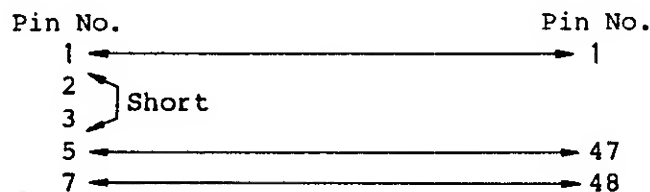
(1) When the T. G. MODE switch has been set to NORMAL.

- ① Connect the COUNTER CONTROL connector on the rear panel of the tracking scope to the DATA OUT. connector of the counter with the dedicated cable (MC-10).

Connect the counter as follows:

TR4120A
Amphenol (57-30240)
equivalent

TR5822
Amphenol (57-30500)
equivalent



However, DATA OUT. of the counter must be output in parallel.

- ② Set the SAMPLE RATE switch of the counter to HOLD.
- ③ Set GATE TIME of the counter as desired.

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TRACKING SCOPE
INSTRUCTION MANUAL

3.6 Frequency Measurement

- ④ Connect the INPUT terminal of the counter to the TG AUX. OUT. terminal on the rear panel of the TR4120A with the BNC cable. Since the input impedance of the counter (TR5822) is $1M\Omega$, connect the terminator of 75Ω (TR1621) to the input connector.
 - ⑤ Since sweeping of the TR4120A is stopped in this state, depress the RESET button of the counter.
 - ⑥ The marker on the spectrum is intensity modulated. Set the marker to the frequency of interest by turning the MARKER POSITION control to obtain the readout on the counter.
- (2) When this switch is set to TUNED AMP.

The signal of the marker which is matched to the signal connected to the INPUT terminal is output at the TG OUT terminal. Consequently, since the instrument functions as a selective amplifier when the T. G. MODE switch is set to TUNED AMP., frequency measurement with the unwanted signals being rejected can be performed. Do not use TUNED AMP. when the tracking scope is used to directly observed frequency response.

Note: Connect the MC-10 cable connector (57-30240), where the cable name plate is stuck, to TR4120A.

- (3) When the T. G. MODE switch has been set to NORMAL.

Adjust FREQ. ADJ. to accurately match the T. G. frequency to the receiving frequency.

To perform this calibration, connect the TG OUT connector with the INPUT connector, set the RESOLUTION BW switch to 100Hz or lower, and adjust the FREQ. ADJ. control so that the level of the trace is maximum.

The T. G. frequency by performing this adjustment with the RESOLUTION BW switch to 10Hz.

- (4) Setting the marker may sometimes become difficult when performing measurement at an extremely slow sweep time. In the case, perform measurement by setting the SWEEP MODE switch to MANUAL, placing the marker with the MANUAL SWEEP control, with the SAMPLE RATE switch of the counter to FAST.

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3.7 Adjustment of CRT Display

3.7 Adjustment of CRT Display

Vertical position, horizontal position, ASTIG., and TRACE ALIGN. adjustments of the CRT display are described here. These adjustments are performed if the TR4120A has not been in use for a long period (more than 3 months) or any time when required. After these adjustments have been completed, perform the level calibration of section 3.3. The adjustment points are located on the left side panel. (See Figure 3-6.) A 3mm flat-tipped screw driver is used for the adjustments.

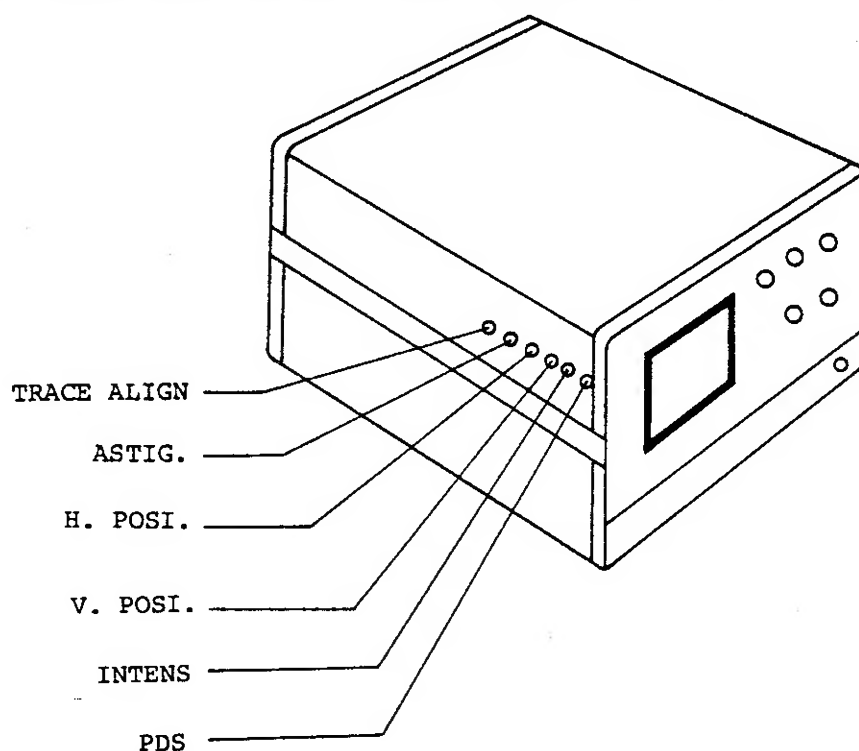


Figure 3 - 6 Adjustment Points of CRT Display

(1) H. POSI.

In turning the SPAN/DIV. switch in steps, the position of the spectrum displayed in the center of the CRT may go on shifting. In this case, adjust the position of the spectrum does not shift with the H. POSI. control.

The adjustment is performed as follows.

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3.7 Adjustment of CRT Display

Adjustment Procedure of H. POSI.

Order	Procedure
1	Set the RESOLUTION BW switch to the 30kHz and the SPAN/DIV. switch to the 20kHz position.
2	Set the peak of the zero frequency spectrum at the center of the CRT display (scale position 0) by means of the COARSE and FINE controls.
3	When the SPAN/DIV. switch is changed from 20kHz to 2MHz, the peak of the spectrum may drift from the center of the CRT display. In this case, adjust the H. POSI. adjuster so that the peak of the spectrum comes to the center of the CRT.

(2) V. POSI.

Adjust the linearity of the vertical axis of the CRT display with the V. POSI. control.

Use a DC voltage generator (output voltage about 0V to 5V, for example, TR6141) in this adjustment. Remove the bottom cover and perform the adjustment in accordance with the procedure table by referring to Figure 3-7.

Adjustment Procedure of V. POSI.

Order	Operation
1	Remove the four bottom cover screws and remove the bottom cover.
2	Disconnect the LOG. AMP. section output connector (J15).
3	Connect the output of an external DC voltage generator to connector J7-12B with a cable (alligator clip - banana clip cable).
4	Set the DC voltage generator output voltage to +2.50V. At this time, adjust the V. POSI. control so that the trace on the CRT display is at the center (LOG. scale position 40).
5	Confirm that the trace is shifted 1 division each time the DC voltage generator output voltage is changed 0.5V.
6	After the end of this adjustment, mount connector J15 and install the bottom cover.

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3.7 Adjustment of CRT Display

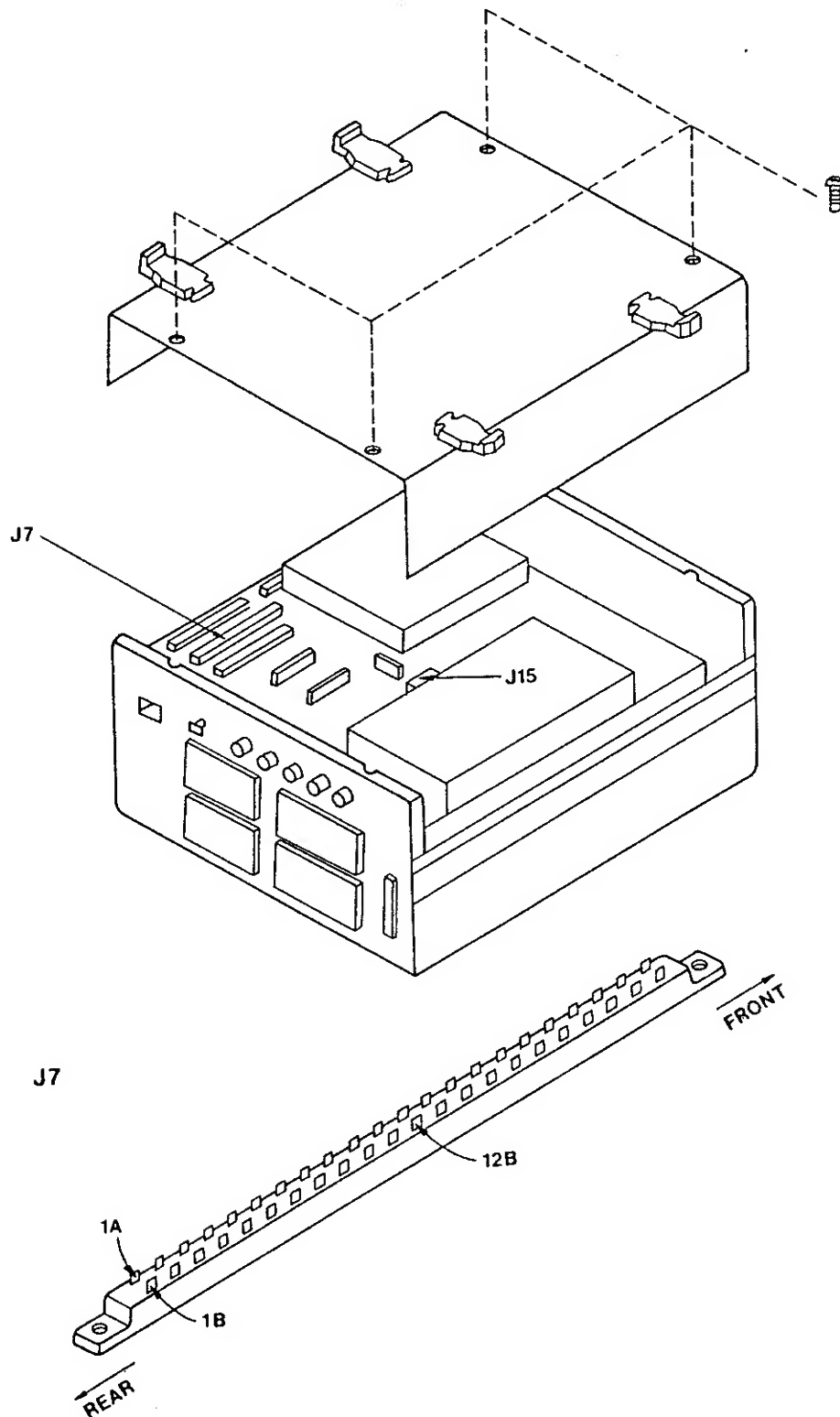


Figure 3 - 7 Adjustment Point of V. POSI.

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TRACKING SCOPE
INSTRUCTION MANUAL

3.7 Adjustment of CRT Display

(3) ASTIG. (Astigmatism)

The ASTIG. adjuster is adjusted to obtain a constant focus over the entire surface of the CRT display.
Adjust it together with the FOCUS control to obtain the best focus.

(4) TRACE ALIGN.

The TRACE ALIGN. adjuster is used to perform correction when the bright line of the CRT display gets titled due to the effect of a magnetic device or a magnetic field.
Adjust this control to make the bright line becomes parallel to the horizontal scale of the CRT display.

MEMO



TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

4.1 Introduction

4. PRINCIPLES OF OPERATION

4.1 Introduction

The TR4120A Tracking Scope is one type of heterodyne receiver. The input signal is converted to a fixed intermediate frequency (IF) and the signals are separated and the level, are read continuously and displayed on a CRT display.

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4.2 Spectrum Analyzer Section

4.2 Spectrum Analyzer Section

The unknown signal connected to the INPUT terminal is passed through RF ATT where it is attenuated, the attenuated signal is passed through an impedance converter circuit and the signal is routed to the 1st MIXER. In the 1st MIXER, this input signal is heterodyned with the signal from the 1st LOCAL and converted to a 50MHz signal to eliminate the image signal. Consequently, the signal from the 1st LOCAL is swept from 50MHz to 80MHz. The 50MHz IF signal is dropped to 8MHz by the 2nd MIXER and then to 3.3MHz by the 3rd MIXER. On the other hand, since the sweep width of the 1st LOCAL is 30MHz, dropping 30MHz to 50Hz/DIV. of DISPERSION/DIV. is extremely difficult. Therefore, the 1st LOCAL is stabilized by phase locking it to a stable crystal oscillator and the 4.7MHz of the 3rd LOCAL is used for sweeping under 10kHz/DIV. The gain of the IF stage is also adjusted when the bandwidth is switched.

The signal passed through this IF stage is routed to the LOG. AMP. The LOG. AMP. is a logarithmic compressor having an 80dB dynamic range and the 80dBm dynamic range can be viewed at a glance. After the LOG. AMP., the signal is detected and the signal is amplified to a voltage capable of driving the CRT display and applied to the Y-axis of the CRT.

TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

4.3 Tracking Generator Section

4.3 Tracking Generator Section

On the spectrum analyzer the incoming frequencies are down-converted to the 3.3MHz IF. In the tracking generator section, however, the 3.3MHz is up-converted to produce the same frequency as that of the input signal. When the T. G. MODE switch is set to NORMAL, 3.3MHz is generated by a crystal oscillator; this 3.3MHz signal is converted to 8MHz by the 3rd LOCAL and then to 50MHz by the 2nd LOCAL. Then, this 50MHz is heterodyned with the signal from the 1st LOCAL to produce frequencies of 0 to 30MHz. The signal is then passed through an LPF., amplified, and then output from the TG OUT terminal as a +10dBm signal.

When T. G. MODE is set to TUNED AMP., the input signal is produced by using the output of LOG. AMP. instead of the 3.3MHz crystal oscillator.

TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

4.4 RF Section (PV059)

4.4 RF Section (PV059)

The input signal passed through RF ATT and the impedance converter circuit is routed from J271. The input signal is passed through an LC low pass filter and applied to mixer MIX-26.6.

On the other hand, the 50MHz to 80MHz signal from the 1st LOCAL is amplified by the amplifier consisting of Q24, Q25 and applied to MIX-1.

At MIX-1, the 50MHz IF signal is output. This 50MHz signal is amplified approximately 11dB by the 50MHz amplifier consisting of Q11, Q12, passed through a 50MHz bandpass filter and applied to the 2nd mixer - MIX-2. Meanwhile, generated by the crystal oscillator (2nd LOCAL) consisting of Q14 and X261, the 42MHz signal is amplified by amplifier Q15, and the amplified signal is output as 2nd LOCAL OUT., passed through the emitter follower Q23 and applied to the 2nd mixer - MIX-267.

At MIX-276 the 50MHz and 2nd LOCAL 42MHz signal are heterodyned and 8MHz is extracted. This 8MHz is then passed through an 8MHz bandpass filter, amplified by Q16, passed through emitter follower Q17, and applied to the 3rd mixer - MIX-268.

When the DISPERSION/DIV. switch is set to 10kHz/DIV. or lower, sweep is performed at the 3rd LOCAL.

The 3rd LOCAL consists of an amplifier (Q18, Q19, Q20), VCO (Q21, Q22, D36, D37, IC1, IC2, Q13), and an linearizer (D31 to 35).

Q13 and D38 are used to adjust the offset of IC2. The ramp voltage from the SWEEP MODE switch and the voltage from the FINE control of TUNING are applied to the other input of IC2.

The VCO comprising Q21, Q22 and voltage variable capacitance diodes D36, D37 oscillates at a frequency of 4.7MHz \pm 60kHz.

The output of IC2 is varied approximately 2V by varying the voltage by means of the SWEEP MODE switch and FINE control. This voltage is applied to the junction of D36, D37 or VCO and the frequency is varied with the voltage.

The linearizer controls the output voltage of IC2 so that the frequency is changed linearly with respect to the voltage.

The output of VCO is amplified by Q20, Q18 and Q19, and one side is output as 3rd LOCAL OUT. and the other is applied to the 3rd mixer - MIX-268 and heterodyned with 3.3MHz to obtain 3.3MHz.

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TRACKING SCOPE
INSTRUCTION MANUAL

4.5 1st LOCAL (PF021)

4.5 1st LOCAL (PF021)

The 1st LOCAL consists of a 50MHz to 80MHz oscillator (Q10, Q9, D20), amplifier (Q6, Q7, Q8, Q22), 1MHz oscillator (Q12, X236), 1/10 divider (IC4), pulser (Q14, Q15), DC amplifier (Q16, Q17, Q18, Q19, Q20, Q21), power supply circuit (IC3) and linearizer (IC1, IC2).

The oscillator consisting of Q10 and D26 oscillates at a frequency of 50MHz to 80MHz. D26 is a voltage variable capacitance diode and is used to change the frequency in accordance with the changes in the ramp voltage from the COARSE control.

The power supply circuit comprising IC3 is used to stabilize the operation of this oscillator. This power supply circuit produces +12.5V and supplies it to Q10.

D26 is inserted into the oven to insure stable operation.

Q9 is an amplifier, but its amplitude is controlled by the limiter consisting of D45, D46. T-226 is used to isolate the output and the signal is sent to the RF section and T. G. section through the emitter follower Q6, Q7.

The signal passed through emitter follower Q8 is amplified by Q22 and sent to the sampler D40, D41.

The 1MHz oscillator consisting of Q12 and X236 is connected to the 1/10 divider IC4 through the level conversion use buffer Q13. The signal divided to 100kHz by the 1/10 divider is converted to a pulse having a sharp rise by the pulser consisting of Q14, Q15.

The 100kHz and 50 to 80MHz signals are applied to the detector consisting of D40, D41 where they are converted to a DC voltage.

The DC voltage is amplified by the DC amplifier consisting of Q16, Q17, Q18, Q19, Q20, and Q21, and sent to IC1 through the limiter comprising D35, D36, D37, and D38.

The change in the voltage produced by SWEEP MODE and COARSE is amplified by IC1, converted to voltage of the voltage variable capacitance diode D36 which varies the frequency linearly.

When DISPERSION/DIV. is set to 10kHz/DIV. or lower, relay K231 is operated, and a phase lock loop is produced.

Phase lock is conducted within the 100kHz range. For example, if the oscillator oscillates at 50.1MHz, the output is 50.1MHz even if the frequency is changed. However, if the frequency approaches 50.2MHz, it is automatically locked at 50.2MHz. Phase lock is applied in 100kHz increments in this manner here.

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TRACKING SCOPE
INSTRUCTION MANUAL

4.6 T. G. Section (PF020)

4.6 T. G. Section (PF020)

The tracking generator section faithfully reproduces the same frequency as that of the receiving signal.

When T. G. MODE is set to TUNED AMP., the 3.3MHz from LOG. AMP. is amplified by Q6. When T. G. MODE is set to NORMAL, the signal from the 3.3MHz crystal oscillator is used. The frequency of the crystal oscillator is used. The frequency of the crystal oscillator can be varied by means of the FREQ. ADJ. control.

The 3.3MHz signal is passed through a 3.5MHz low pass filter. This filter is set to 3.5MHz in order to provide a certain amount of frequency change relative to 3.3MHz.

The signal passed through the filter is sent to the mixer - MIX-271. The other input signal of the mixer is the 4.7MHz from the 3rd LOCAL. The 4.7MHz signal is passed through isolated amplifier Q9, Q10 and sent to the mixer. The output of the mixer is 8MHz.

The 8MHz signal is passed through a band pass filter, amplifier Q11, Q12 and sent to mixer - MIX272. The other input of this mixer is the 42MHz signal from the 2nd LOCAL. This signal is amplified by Q13, Q14 and applied to the mixer through emitter follower Q15. The output of this mixer is 50MHz.

The output of the mixer is amplified by Q16, passed through emitter follower Q17, Q18, and sent to mixer - MIX273 through a 50MHz bandpass filter.

The other input of the mixer is the 50MHz to 80MHz signal from the 1st LOCAL.

The output of the mixer is passed through a 30MHz low pass filter, amplified, then output from the TG OUT terminal. The signal from the collector of Q12 is amplified and output as TG AUX. OUT.

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4.7 RAMP and WARNING Section (PF022)

4.7 RAMP and WARNING Section (PF022)

The sweep signal is generated by a trigger circuit and sweep signal generator circuit.

When SWEEP TRIGGER is set to LINE or EXT., the signal is passed through impedance converter circuit Q11 and applied to trigger circuit Q12, Q13. The trigger circuit is operated as a Schmitt trigger circuit. When SWEEP TRIGGER is set to AUTO, the trigger circuit is operated as an astable multivibrator. The sweep signal is generated by means of the signal from the trigger circuit. The sweep signal generator consists of a gate comprising Q15, D39, D40, and D41 and the Miller integrating circuit is operated by Q16, Q17, Q18, and Q19.

IC1 performs the level shift operation.

The WARNIG lamp circuit is driven by IC3 and Q24.

If the SWEEP TIME, SPAN/DIV., RESOLUTION BW, or VIDEO BANDWIDTH switches are set erroneously, the voltage in accordance with the setting of each switch are added at the input of IC2, Q24 is driven, and the WARNING lamp is lighted.

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TRACKING SCOPE
INSTRUCTION MANUAL

4.8 LC Filter Section (PK009)

4.8 LC Filter Section (PK009)

The 3.3MHz signal from the RF section is passed through an LC bandpass filter, level compensation is performed, and the resultant signal is applied to the circuit consisting of Q6. The signal is then applied to the 10dB step amplifier Q14, Q12, Q13. This amplifier is a 3-stage 10dB step amplifier which controls the gain of the IF stage.

The amplified signal is applied to the variable bandwidth filter consisting of Q14, Q15, Q16, and Q17. This filter is used to change the bandwidth by means of the RESOLUTION BW switch. The signal is then applied to the level compensation circuit consisting of Q18, Q19 and the level is changed by voltage variable capacitance diodes D86, D87. This is performed by means of IF LEVEL ADJ. Next, this signal is applied to the 3-stage 10 dB step amplifier. The 10dB step amplifier is matched to the previous 3 stages and is varied 0 to 60dB by means of REFERENCE LEVEL.

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INSTRUCTION MANUAL

4.9 Crystal Filter Section (PK008)

4.9 Crystal Filter Section (PK008)

This filter is operated when RESOLUTION BW is set to a narrow band.
Q1 to Q6 are the variable bandwidth filters ganged with 3kHz, 1kHz, and 300Hz.
Q7 to Q9 are the level compensation use amplifiers.
Q10 to Q16 are the variable bandwidth filters ganged with 100Hz, 30Hz, and 10Hz.
Q17 to Q19 are the level compensation use amplifiers used to make the output level flat.

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INSTRUCTION MANUAL

4.10 LOG. AMP. Section (PH066)

4.10 LOG. AMP. Section (PH066)

This section consists of ten 10dB amplifier stages employing two of transistors Q6 to Q25.

This amplifier is necessary in order to provide an 80dB dynamic range.

This amplifier is saturated from the later stage.

The output of these amplifiers are sampled by the sampling amplifier Q26, Q27 and amplifier Q28, Q29 to approximate a LOG. output.

The output of this amplifier is amplified by Q32, detected by Q33, Q34, D40, and D41, and output through the DC amplifier IC1.

This LOG. AMP. not only performs LOG. conversion of the DC signal generally used, but also performs LOG. conversion of AC signal and thus provide an extremely stable LOG. characteristic.

TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

5.1 Introduction

5. MAINTENANCE

5.1 Introduction

Maintenance of the TR4120A is described here. Always perform maintenance carefully by referring to the circuit diagrams.

TR4120A
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INSTRUCTION MANUAL

5.2 Test Equipment Required in Maintenance

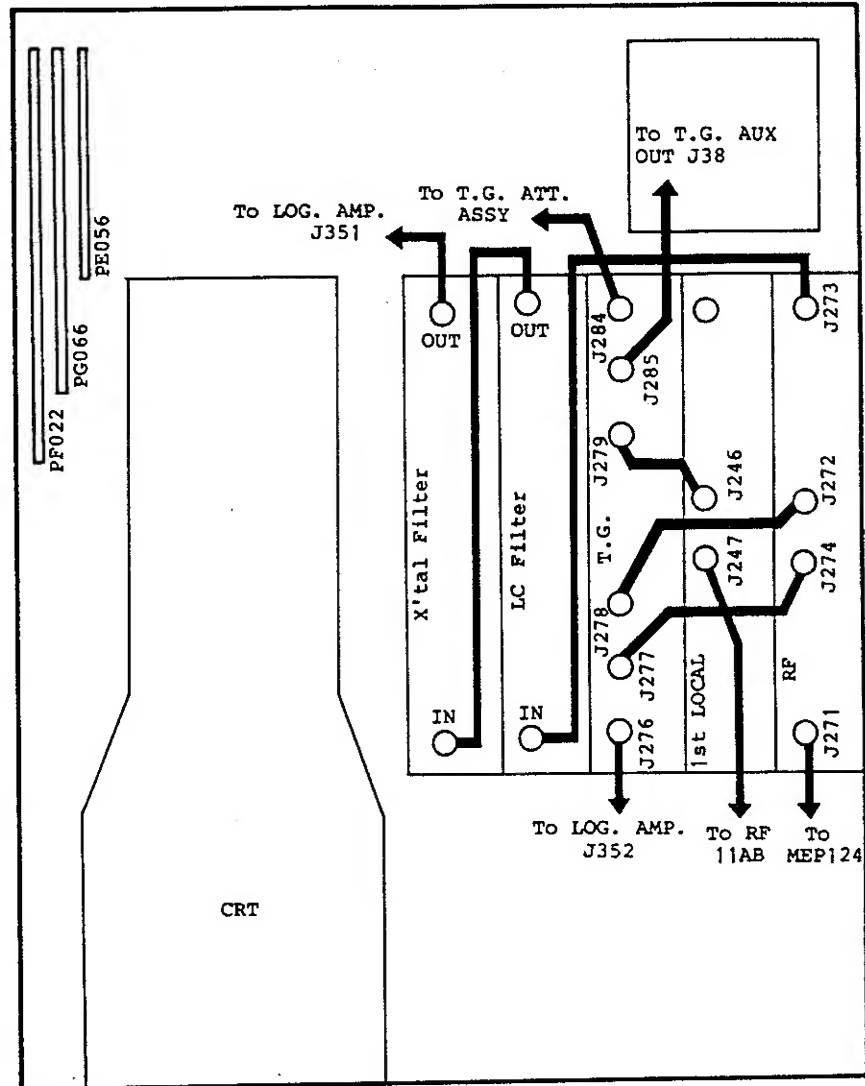
5.2 Test Equipment Required in Maintenance

Equipment	Ratings	Recommended instrument
Tracking scope	Measurement range 100kHz to 1500MHz (Maximum input sensitivity -120dBm Must be equipped with a counter use output.)	TR4110/4113
Frequency counter	Measurement range DC to 60MHz Maximum input sensitivity 50mVrms	TR5822
Synthesizer	Frequency range 100kHz to 100MHz Output level +10 to -60dBm Output impedance 50Ω	
Attenuator	Range 0 to 80dB Input impedance 50Ω	
Terminator	50Ω, 75Ω 1/2W	TR1622/21
Digital voltmeter	Measurement range 0 to ±1000VDC Accuracy ±0.005% of rdg. Input impedance or more 10MΩ or greater	TR6855
Oscilloscope	Measurement range DC to 60MHz Input sensitivity 1mV or more	
Signal generator	Frequency range 10Hz to 80MHz Output voltage -60dBm or more	
Pulse generator	Frequency range 1Hz to 50MHz Output amplitude 0.2V to 10V Pulse width 10ns to 100ms	
Tracking scope	Measurement range 100Hz to 30MHz Maximum input sensitivity -130dBV or more Resolution 10Hz	TR4120A
Measurement	Connector UM-01P-1.5, UG-88/U Cable 1.5 DXW. 1.5m long	MC-36

TR4120A
TRACKING SCOPE
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5.3 Connection Diagram

5.3 Connection Diagram



Front Panel

Figure 5 - 1 Cable Interconnection of the TR4120A

TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

5.4 RF Section

5.4 RF Section

(1) 3rd LOCAL Adjustment

① Frequency Check

Disconnect the cable connected to J274, and connect J274 to the frequency counter with the MC-26 cable. Then, measure the frequency. Check that the frequency should be within the range from 4.81MHz to 4.55MHz.

When this condition is not satisfied, the linearizer must be checked.

② Level Check

Set SPAN/DIV. to 2MHz/DIV. and RESOLUTION BW to 100kHz. Connect the INPUT terminal to J274. 50 Ω termination should be connected to the INPUT terminal.

The level from J274 must be over -5dBm and harmonics must be under -15dB.

(2) 2nd LOCAL Adjustment

① Frequency Check

Connect the frequency counter to J276 by cable and read the frequency. Must be 42MHz \pm 3MHz.

② Level Check

Read the output signal of J272 with a tracking scope.

The level must be over -10dBm and harmonics must be under -20dB.

(3) Level Check from J271 to J276

Set SPAN to ZERO and SPAN/DIV. to 20kHz/DIV. and apply a 5MHz, -30dBm signal from a signal generator to J271. Connect the tracking scope to J276 and adjust the COARSE control of the TR4120A for maximum 50MHz spectrum. The level at this time must be over -34dBm. Moreover, confirm that the deviation at 50MHz \pm 200kHz is within \pm 0.2dB.

(4) Level Check from J275 to J273

Apply a 50MHz, -30dBm signal from the signal generator to J275. Connect the tracking scope to J273.

Confirm that the 3.33MHz level at this time is -38dBm or more.

Confirm that the deviation for a change of 3.3MHz \pm 150kHz is within \pm 0.4dB.

At this time, set the FINE control to the center.

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TRACKING SCOPE
INSTRUCTION MANUAL

5.4 RF Section

(5) Linearizer Check

Set SPAN/DIV. to 10kHz/DIV. and RESOLUTION to 1kHz.

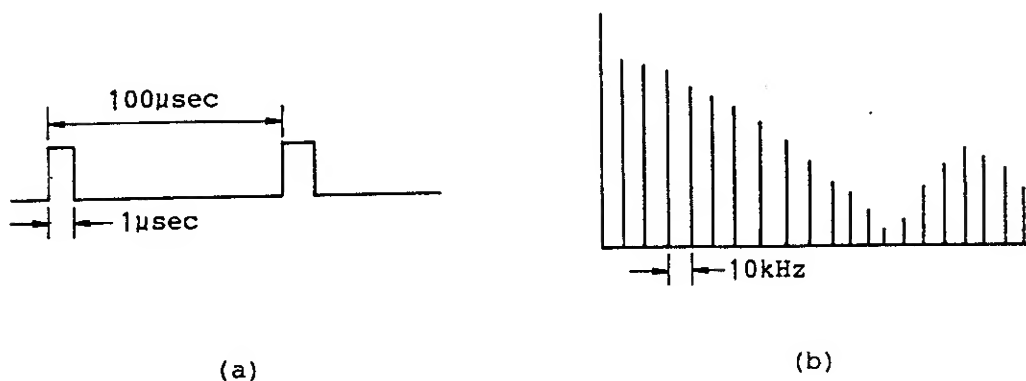


Figure 5 - 2

When a waveform such as that illustrated in Figure 5-2 (a) is applied to the INPUT terminal, a spectrum appears on the CRT display at 10kHz intervals as shown in Figure 5-2 (b).

Adjust R110, R98 to R104 so that this spectrum coincides with the graticule of the CRT display.

At this time, turn the FINE control from full left to full right and confirm that the spectrum is shifted more than 120kHz and that the linearity over this range is within 10%.

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5.5 1st LOCAL Adjustment

5.5 1st LOCAL Adjustment

(1) Oscillation Level Check

Connect the tracking scope to J297.

Confirm that the output level is over -10dBm and the deviation is 2dB or less at an oscillation frequency of 50MHz to 80MHz.

(2) Sampling Pulse Check

Check that the waveforms shown in Figure 5-3 are displayed.

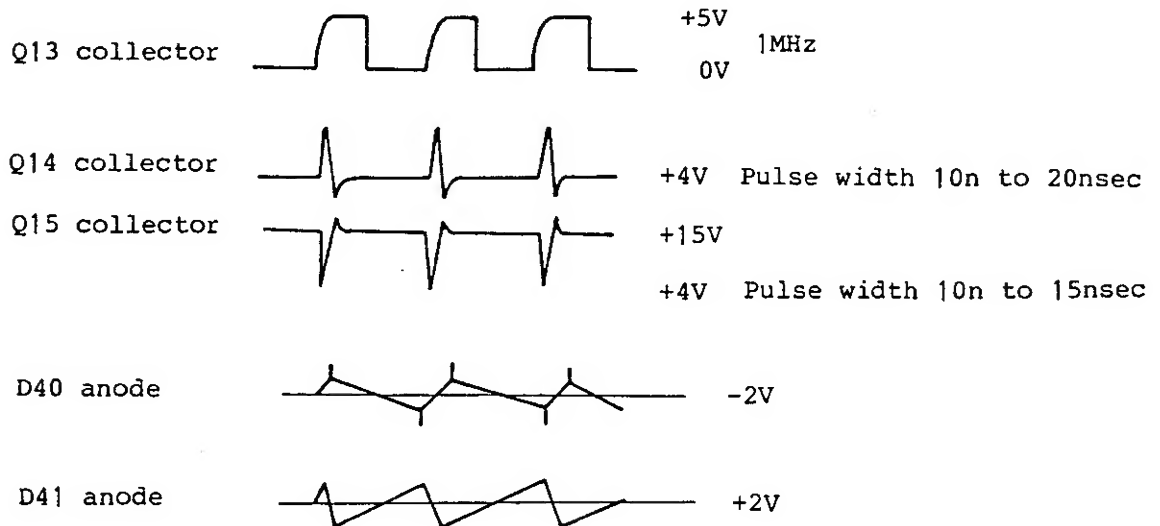


Figure 5 - 3

(3) Oscillation Output Check at the Time of Phase Lock

Set SPAN/DIV. of the tracking scope to 50kHz/DIV. and RESOLUTION BW to 1kHz.

Adjust R115 so that the sampling pulse output is -70dB or less at J297.

Adjust R125 so that the frequency variation range is under 50kHz when phase lock is applied.

Adjust R126 for minimum phase noise.

(4) Linearizer Check

Set SPAN/DIV. to 1MHz and RESOLUTION BW to 100kHz and adjust R65 so that the 0MHz signal is at the center of the CRT display when the center frequency is set to 0MHz.

Next, connect a signal having a 20ns pulse width and 1μs pulse interval to INPUT connector and adjust R81 to R88 or R96 so that its spectrum coincides with the CRT display graticule.

Then apply a 30MHz signal and adjust R96 so that the spectrum is at the center of the CRT display when the center frequency is set to 30MHz.

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INSTRUCTION MANUAL

5.6 T.G. Section Adjustment

5.6 T.G. Section Adjustment

(1) 8MHz and 50MHz Bandpass Filter Check

- ① Set the tracking scope controls as follows:

SPAN/DIV.	500kHz/DIV.
RESOLUTION BW	10kHz
SWEEP TIME/DIV.	Arbitrary
INPUT ATT	30dB
REFERENCE LEVEL	10dBV
INPUT	Terminate in 75 Ω
T. G. OUT.	4.7MHz, -10dBm

- ② Follow the connection diagram of figure 5-4 and confirm that the spectrum is displayed as shown in Figure 5-5.

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TRACKING SCOPE
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5.6 T.G. Section Adjustment

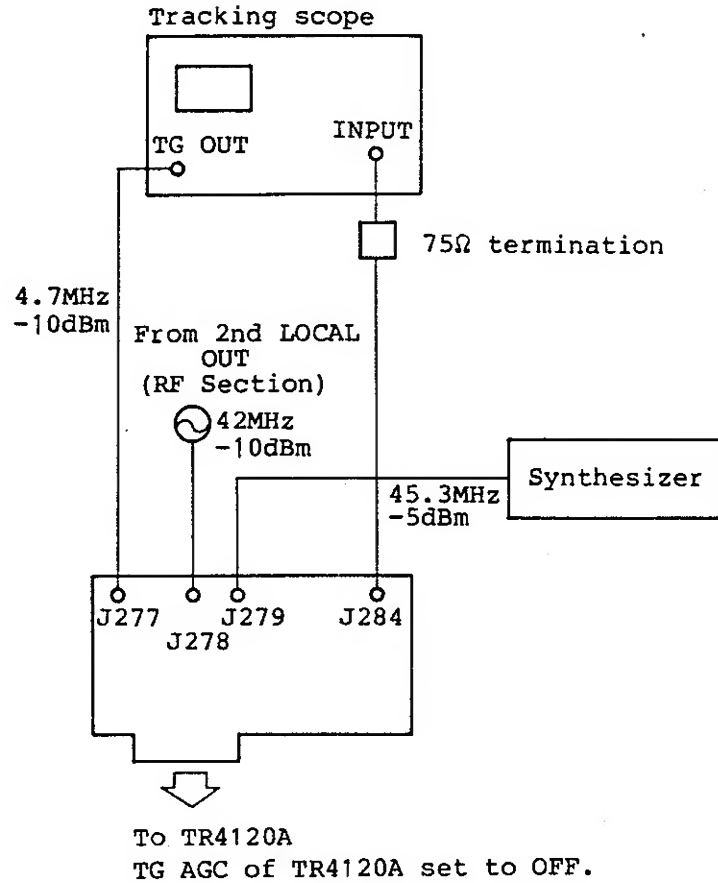


Figure 5 - 4 Connection Diagram

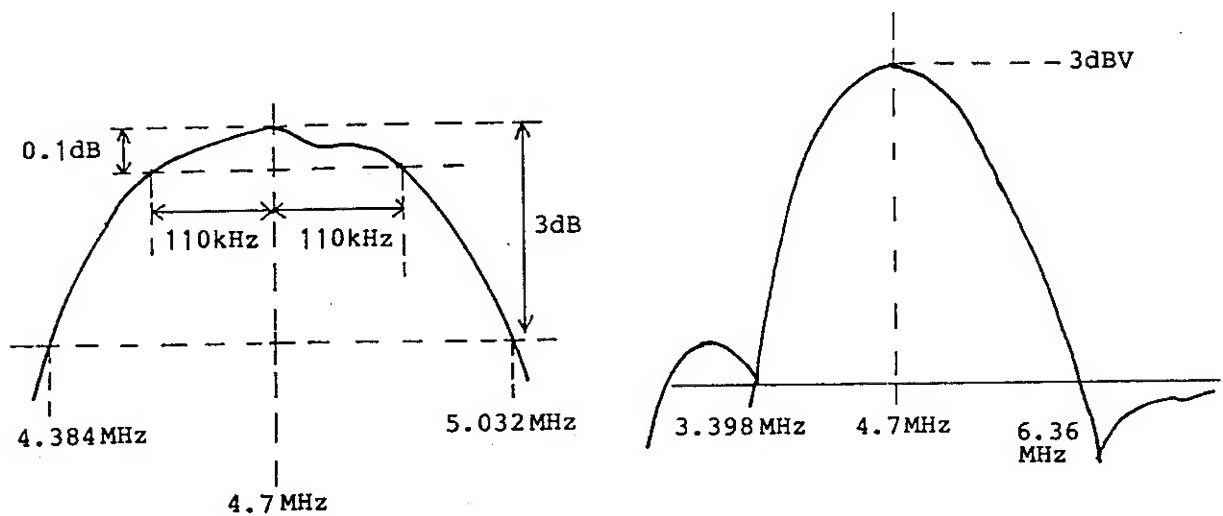


Figure 5 - 5 Frequency Characteristic

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TRACKING SCOPE
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5.7 LC Filter Adjustment

5.7 LC Filter Adjustment

See the Figure 5-6 connection diagram for the setup.
Adjust the variable resistors to obtain the level as illustrated in Figure 5-7.

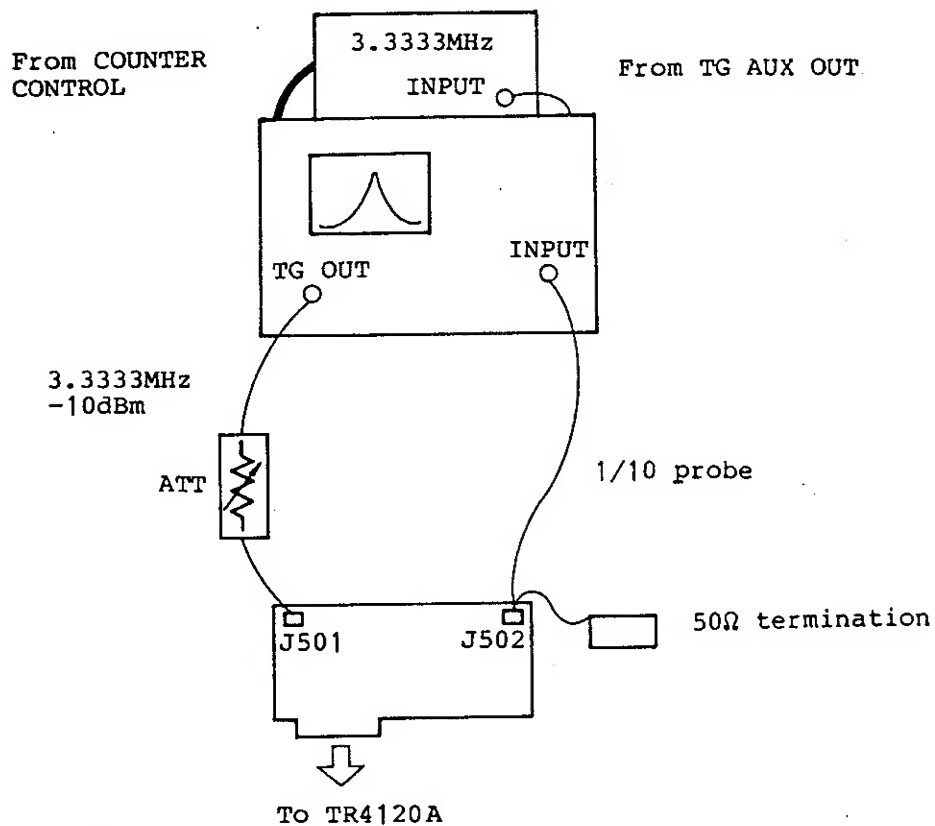


Figure 5 - 6 Connection Diagram

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TRACKING SCOPE
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5.7 LC Filter Adjustment

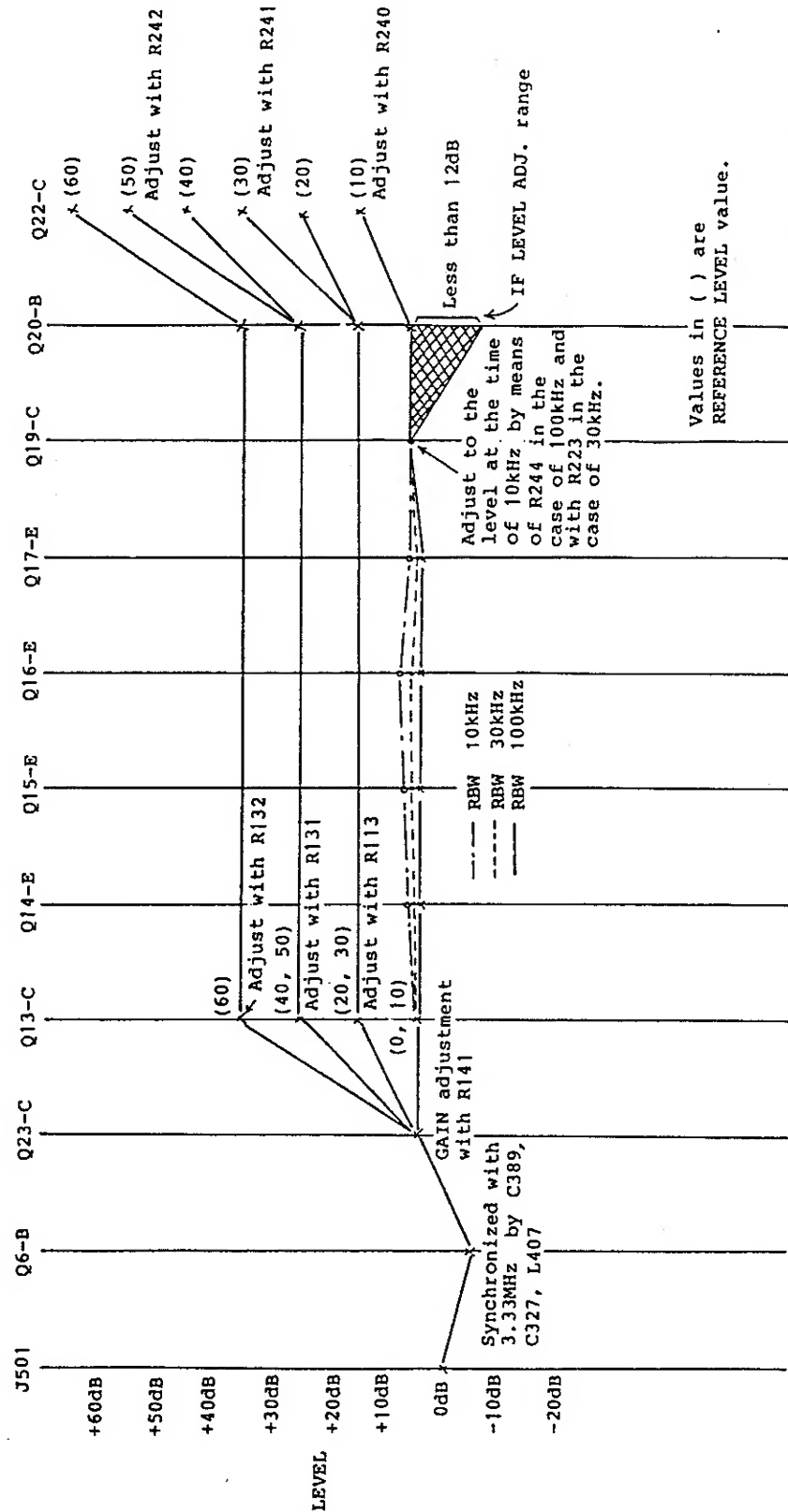


Figure 5 - 7

TR4120A
TRACKING SCOPE
INSTRUCTION MANUAL

5.8 Crystal Filter Adjustment

5.8 Crystal Filter Adjustment

See Figure 5-8 Connection Diagram for the setup.

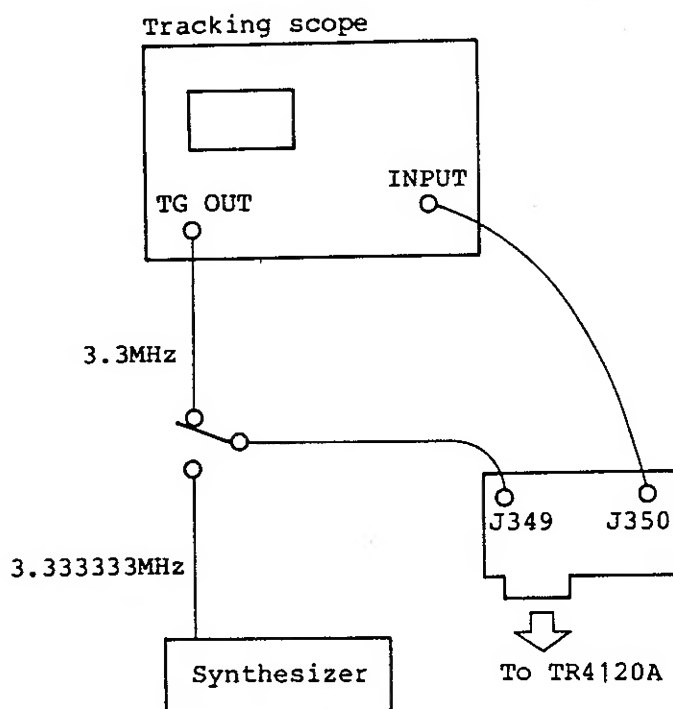


Figure 5 - 8 Connection Diagram

- (1) In the case of RESOLUTION BW of 3kHz, 1kHz, and 300Hz, adjust by setting T. G. OUT. of the tracking scope to 3.3MHz and RESOLUTION BW to 3kHz.
Adjust the symmetry with C223, C228, and C233 and the center frequency with C225, C230, C235.
1kHz, 300Hz, Calibrate the level at 1kHz and 300Hz with R134 and 3kHz with R135.
- (2) In the case of RESOLUTION BW of 100Hz, 30Hz, and 10Hz, apply a 3.333333MHz signal from the synthesizer to the INPUT connector and adjust C258, C250, C266, C270, and C272 for maximum peak when RESOLUTION BW is set to 10Hz, and adjust R169, R207, and R208 so that the output level is the same as for 3kHz.

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5.9 Adjustment of LOG. AMP. Section (PH066)

5.9 Adjustment of LOG. AMP. Section (PH066)

Follow the setup connection in Figure 5-9 and check the expected waveforms at the test point in Figure 5-10.

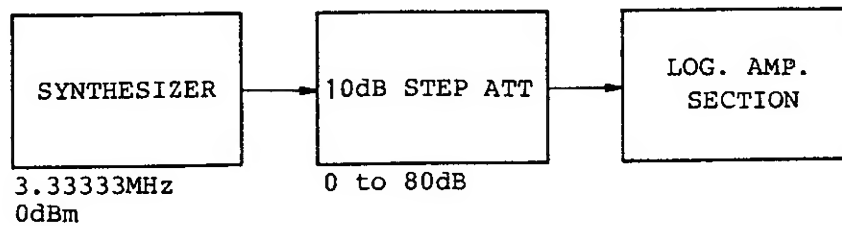


Figure 5 - 9 Connection

Input/output frequency character

Input (J351)	Output (Pin 2)
0dBm	+4.5V $\pm 0.02V$
-10dBm	+4.0V $\pm 0.02V$
-20dBm	+3.5V $\pm 0.02V$
-30dBm	+3.0V $\pm 0.02V$
-40dBm	+2.5V $\pm 0.02V$
-50dBm	+2.0V $\pm 0.02V$
-60dBm	+1.5V $\pm 0.02V$
-70dBm	+1.0V $\pm 0.02V$
-80dBm	+0.5V $\pm 0.02V$

TR4120A
TRACKING SCOPE
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5.9 Adjustment of LOG. AMP. Section (PH066)

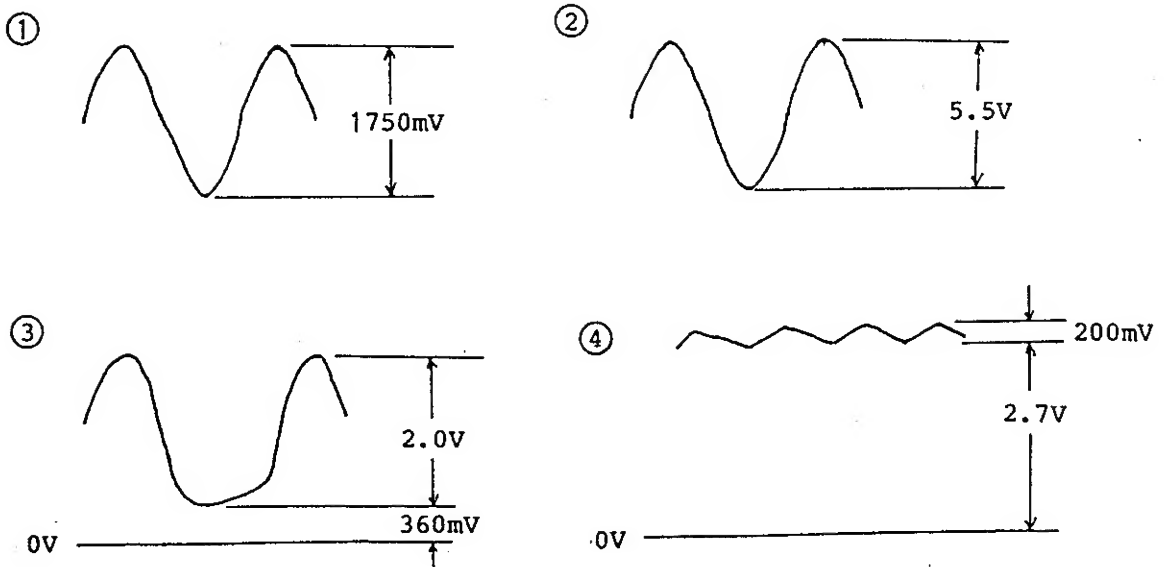
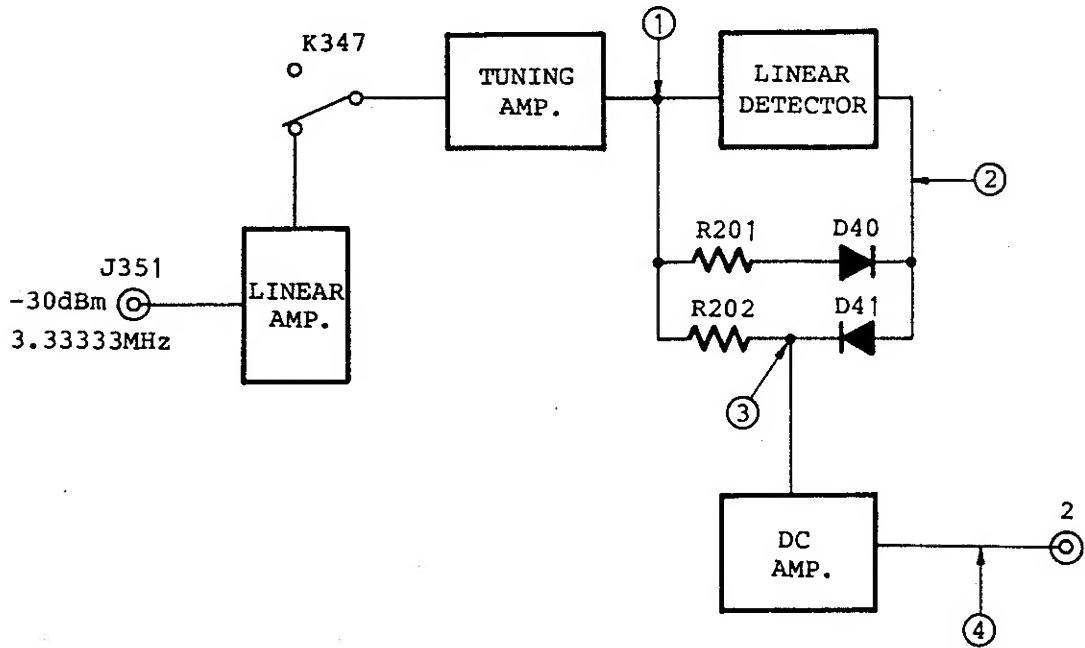


Figure 5 - 10 Test Point and Waveforms

TR4120A
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INSTRUCTION MANUAL

5.10 Adjustment of RAMP GEN. Section (PF022)

5.10 Adjustment of RAMP GEN. Section (PF022)

Waveforms of each point are shown in Figure 5-11.

Waveforms

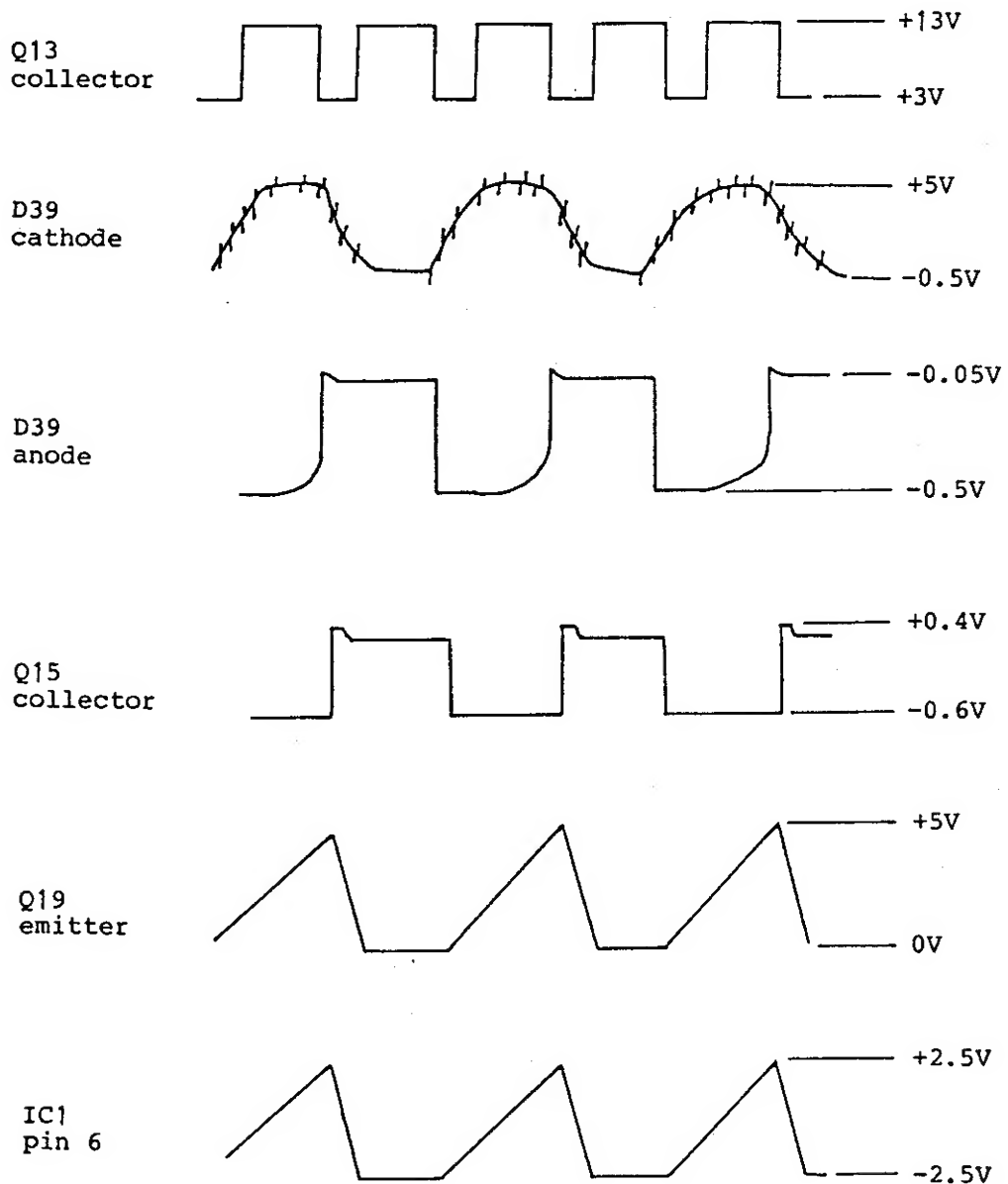
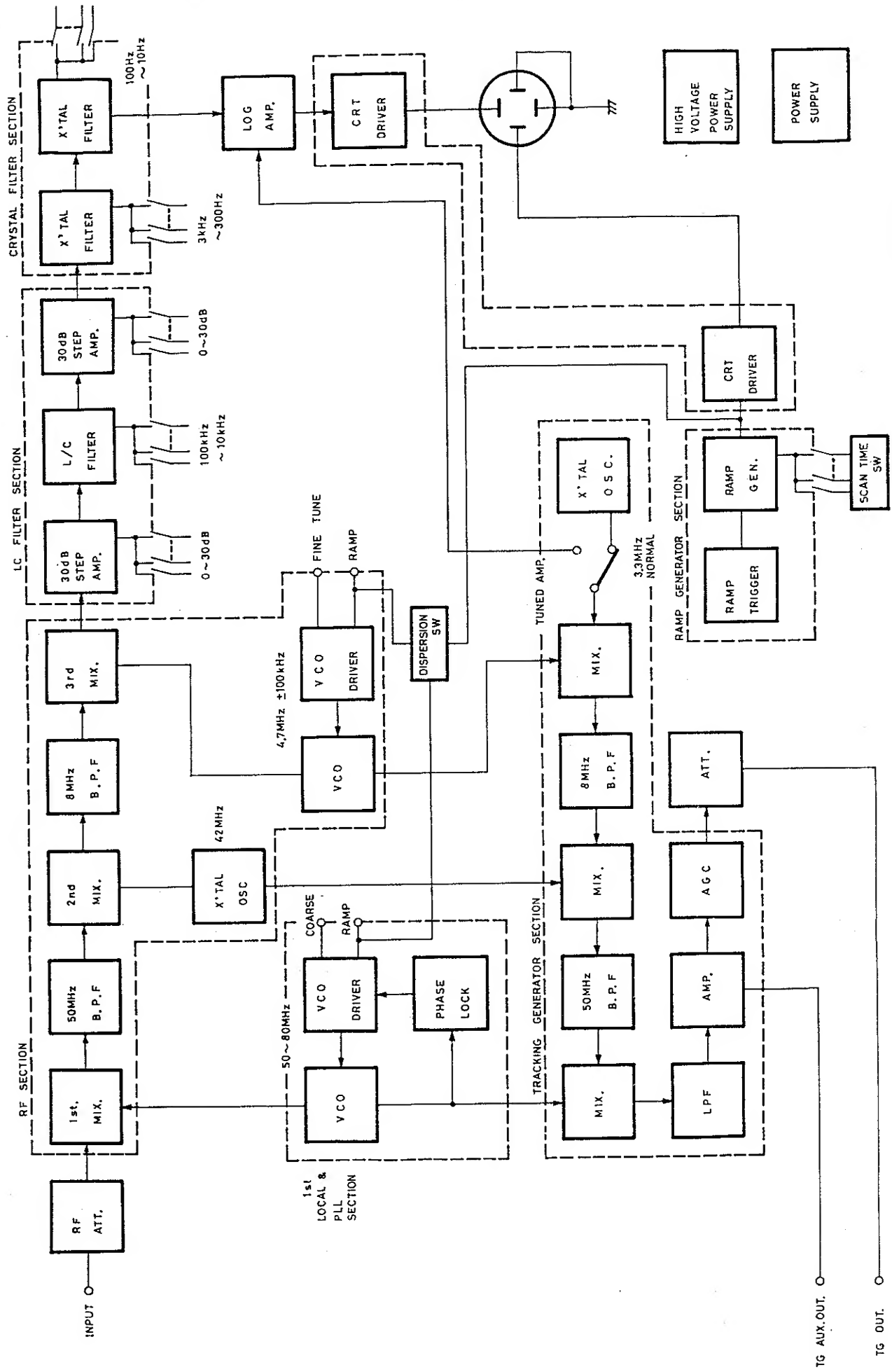
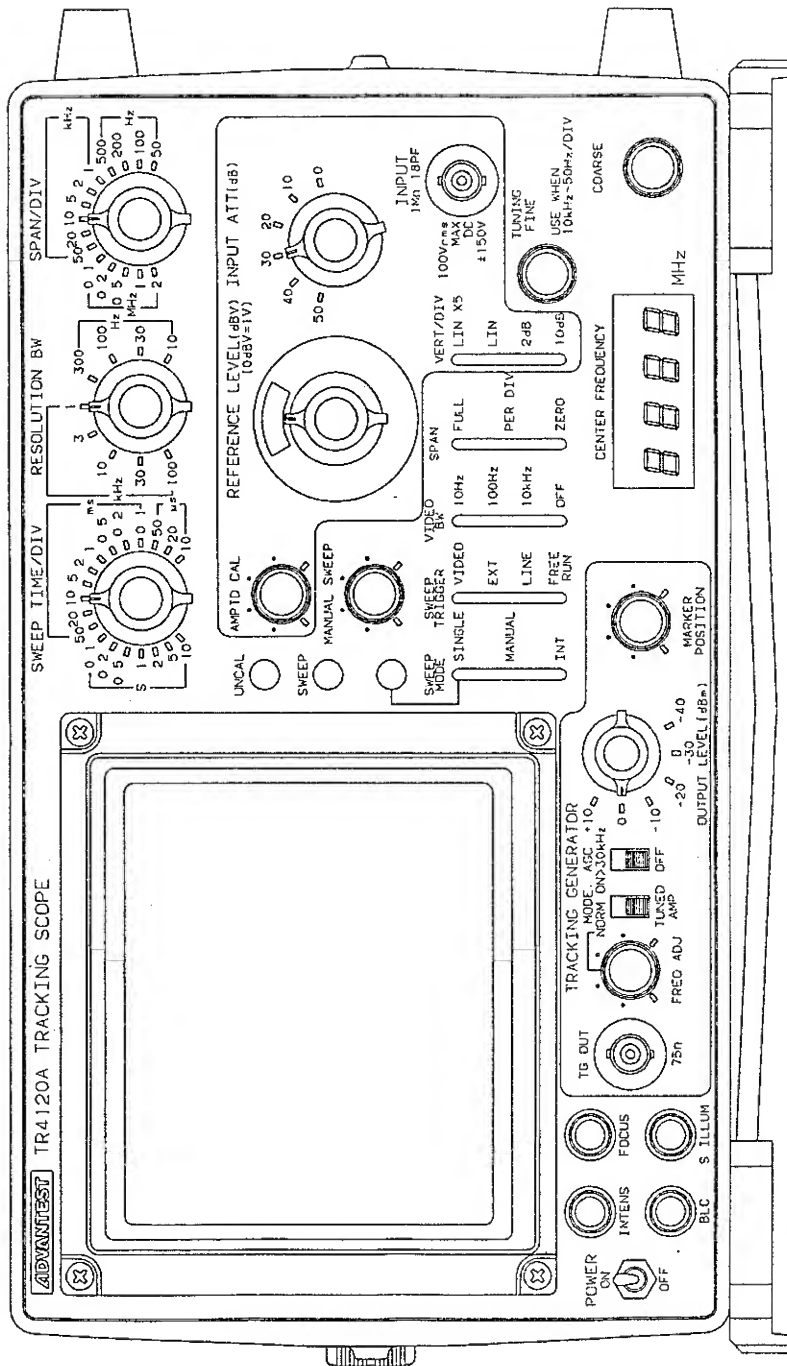


Figure 5 - 11 Waveforms at Each Point



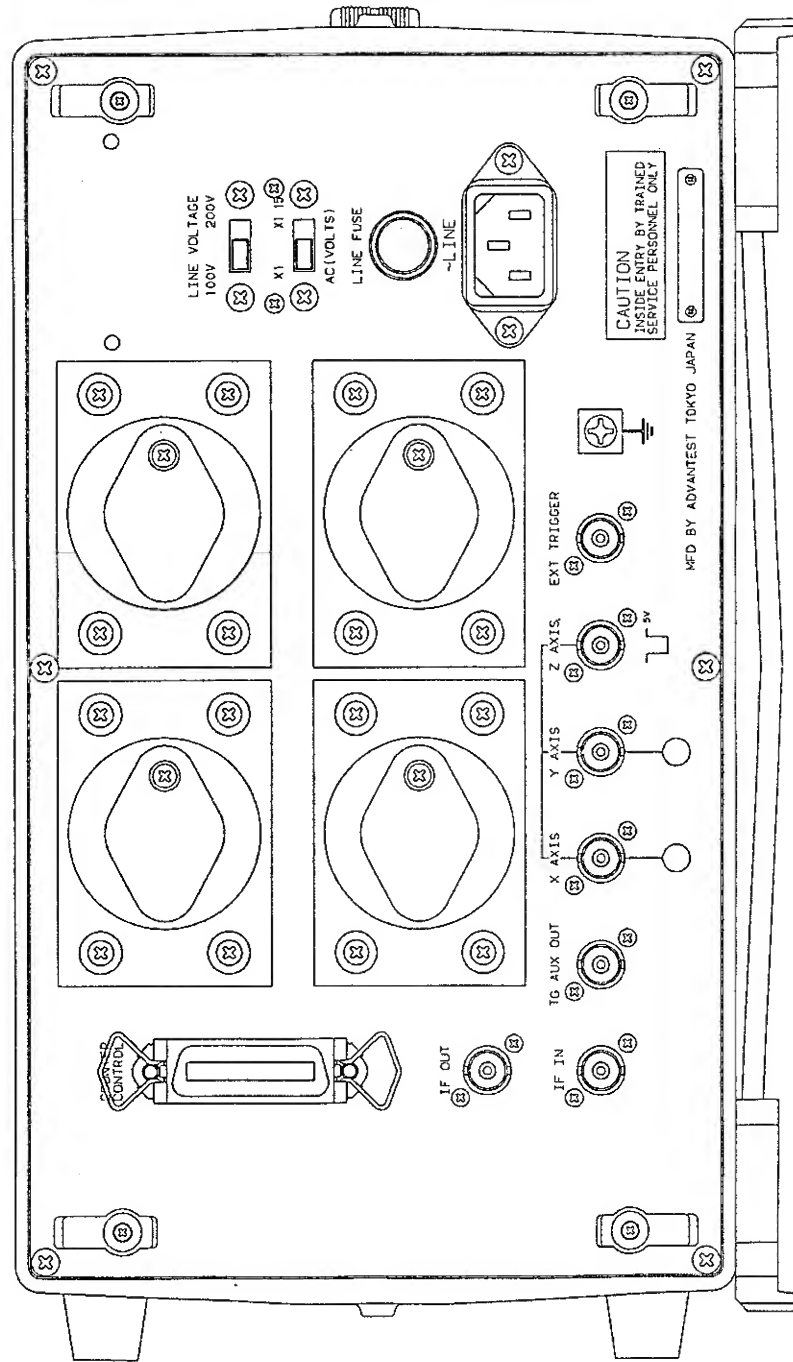
TR4120A
BLOCK DIAGRAM



TR4120A

FRONT VIEW

TR4120AEXT2-908-B



TR4120A
REAR VIEW

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